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1993
Executive Research Project
RS5

# The Defense Acquisition Challenge: A Strategy for Improving Weapon System Affordability

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Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

# REPORT DOCUMENTATION PAGE

| | |
|---|---|
| 1a. REPORT SECURITY CLASSIFICATION<br>Unclassified | 1b. RESTRICTIVE MARKINGS |
| 2a. SECURITY CLASSIFICATION AUTHORITY<br>N/A | 3. DISTRIBUTION/AVAILABILITY OF REPORT<br>Distribution Statement A: Approved for public release; distribution is unlimited. |
| 2b. DECLASSIFICATION/DOWNGRADING SCHEDULE<br>N/A | |
| 4. PERFORMING ORGANIZATION REPORT NUMBER(S)<br>NDU-ICAF-93- R85 | 5. MONITORING ORGANIZATION REPORT NUMBER(S)<br>Same |
| 6a. NAME OF PERFORMING ORGANIZATION<br>Industrial College of the Armed Forces<br>6b. OFFICE SYMBOL (If applicable)<br>ICAF-FAP | 7a. NAME OF MONITORING ORGANIZATION<br>National Defense University |
| 6c. ADDRESS (City, State, and ZIP Code)<br>Fort Lesley J. McNair<br>Washington, D.C. 20319-6000 | 7b. ADDRESS (City, State, and ZIP Code)<br>Fort Lesley J. McNair<br>Washington, D.C. 20319-6000 |
| 8a. NAME OF FUNDING/SPONSORING ORGANIZATION<br>8b. OFFICE SYMBOL (If applicable) | 9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER |
| 8c. ADDRESS (City, State, and ZIP Code) | 10. SOURCE OF FUNDING NUMBERS<br>PROGRAM ELEMENT NO. / PROJECT NO. / TASK NO. / WORK UNIT ACCESSION NO. |

11. TITLE *(Include Security Classification)*
The Defense Acquisition Challenge: a Strategy for Improving Weapon System Affordability

12. PERSONAL AUTHOR(S) Robert N. Gamache

| 13a. TYPE OF REPORT | 13b. TIME COVERED | 14. DATE OF REPORT (Year, Month, Day) | 15. PAGE COUNT |
|---|---|---|---|
| Research | FROM Aug 92 TO Apr 93 | April 1993 | 48 |

16. SUPPLEMENTARY NOTATION

| 17. COSATI CODES | | | 18. SUBJECT TERMS *(Continue on reverse if necessary and identify by block number)* |
|---|---|---|---|
| FIELD | GROUP | SUB-GROUP | |
| | | | |
| | | | |

19. ABSTRACT *(Continue on reverse if necessary and identify by block number)*

SEE ATTACHED

| | |
|---|---|
| 20. DISTRIBUTION/AVAILABILITY OF ABSTRACT<br>☒ UNCLASSIFIED/UNLIMITED ☒ SAME AS RPT. ☐ DTIC USERS | 21. ABSTRACT SECURITY CLASSIFICATION<br>Unclassified |
| 22a. NAME OF RESPONSIBLE INDIVIDUAL<br>Judy Clark | 22b. TELEPHONE (Include Area Code)<br>(202) 475-1889<br>22c. OFFICE SYMBOL<br>ICAF-FAP |

DD FORM 1473, 84 MAR

83 APR edition may be used until exhausted.
All other editions are obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
UNCLASSIFIED

**THE DEFENSE ACQUISITION CHALLENGE:**
**A STRATEGY FOR IMPROVING WEAPON SYSTEM AFFORDABILITY**

by
Lt Col Robert N. Gamache, USAF

## ABSTRACT

An approach is presented to maintain the technological supremacy of U.S. weapon systems at a more affordable cost. This is the defense acquisition challenge for the 1990s. Seven cost drivers, judged to be among the leading sources of cost growth in our major acquisition programs, are examined in detail. The top three determinants of cost are related to a common theme--the need for more disciplined program execution. The remaining cost drivers are associated with either the program initiation process or systemic problems in the defense industrial base. From this discussion, a strategy is developed to change the acquisition culture--one that elevates the importance of cost control and puts this imperative on an equal footing with expanding the performance envelope. Policy recommendations are offered for consideration by senior defense acquisition officials.

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# DISCLAIMER

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## INTRODUCTION

The U.S. defense establishment has developed and fielded weaponry that is clearly second to none--either in technological superiority[1] or in excessive cost.[2] The post-cold war national security environment has created an imperative to reduce defense budgets still further. Hence, our challenge is to craft a different acquisition approach--one that maintains the technological supremacy of U.S. weapon systems at a more affordable cost.

In July 1992, the Department of Defense announced a new Science and Technology (S&T) strategy[3,4] to deal with this acquisition challenge. This new S&T approach contained many of the resource strategy elements proposed earlier in February 1992 by Representative Les Aspin.[5] Under either approach, force modernization improvements will occur less frequently. Technology will be matured through successive generations in a laboratory environment before entering the Department's formal acquisition pipeline. Hence, the new S&T strategy emphasizes technology "roll over" and limited numbers of operational prototypes rather than high volume production. No changes were made to improve the acquisition process itself. However, the Director of Defense Research and Engineering (DDR&E) was given additional authority to exert more centralized control over the defense science and technology program. In theory, the DDR&E will use this authority to eliminate duplication among the military services.

I believe that the new S&T strategy is a step in the right direction. However, the Department of Defense should pursue a more comprehensive approach--one where we also seek to improve the weapon system development process itself. From a program execution standpoint, this means elevating the importance of cost control--to put this imperative on an equal footing with expanding the performance envelope of our weapon systems. It

**TABLE I**
**WEAPON SYSTEM COST DRIVERS**

| COST DRIVER | COST IMPACT PRIORITY | ACQUISITION CATEGORY | Addressed by S&T Strategy |
|---|---|---|---|
| Ineffective Program Leadership | 1 | Program Execution | No |
| Compartmented Product Development | 2 | Program Execution | No |
| Inadequate Planning Discipline | 3 | Program Execution | No |
| Faulty Requirements Generation | 4 | Program Initiation | No |
| Premature Technology Transition | 5 | Program Initiation | Partially |
| Excess Capacity | 6 | Industrial Base | No |
| Low Productivity Growth | 7 | Industrial Base | No |

also means that we should improve the way we start our major defense acquisition programs. And finally, we need to actively rationalize the structure of the defense industrial base. The goal should be to create a "dual-use" economy--a single, integrated industrial base which produces globally competitive commercial and defense goods. This more comprehensive strategy complements the announced S&T strategy by fixing downstream problems in the acquisition pipeline. As a result, technologies which emerge from multiple "roll over" iterations will be fielded at a lower cost and on a shorter development cycle.

Seven cost drivers, judged to be among the leading sources of cost growth in modern weapon systems, are examined in this paper. These drivers are listed above in Table I according to their relative impact on cost. A generic acquisition category is given in column three. The remaining column shows that the new

S&T strategy partially addresses only one leading source of cost growth--premature technology transition. In theory, every program's acquisition strategy should address each cost driver.

In this paper, the relevant issues associated with each cost driver are explored in detail. From this discussion, a total of 32 specific policy recommendations (see Table II) are offered for consideration by senior acquisition officials. We will begin by looking at the more obvious elements of the defense acquisition challenge--the major cost drivers and recommended policy changes in the way we execute our weapon system acquisition programs.

## PROGRAM EXECUTION

There has been no shortage of prior inquiry into the issue of acquisition reform.[6] Many investigators tend to focus on program instability[7,8,9] or over regulation[10,11] as the primary causes of weapon system cost growth. Their recommended reforms are oriented towards control of the "external" sources of program instability and regulation--limit reporting requirements, shorten command channels, and permit multiyear procurement funding--to name a few. However, we should begin with measures designed to promote more disciplined program execution (see Table I). I believe that a well-run program will possess the internal strength needed to control costs in an inherently unstable and over regulated acquisition environment. This includes the quality of the program leadership, the effectiveness of the product development effort, and the degree of planning discipline and flexibility present in the program office.

### INEFFECTIVE PROGRAM LEADERSHIP

Good leadership improves affordability by producing the right decision at the right time. There are many excellent references on the characteristics of good leaders,[12,13] leadership case studies,[14] and the development of leadership potential.[15,16] Rather than reiterate the need for good

**TABLE II**
**WEAPON SYSTEM AFFORDABILITY STRATEGY**

| COST DRIVER | POLICY RECOMMENDATION |
|---|---|
| | **a. Program Execution** |
| Ineffective Program Leadership | 1. Program Director's Authority<br>2. Life Cycle Weapon System Management<br>3. Communications-Computer Systems |
| Compartmented Product Development | 4. Contracting Practices<br>5. Performance-Cost Trade Flexibility<br>6. Low Cost Design Practices<br>7. Computer-aided Acquisition<br>8. Manufacturing Technology Deployment<br>9. Design Culture Harmonization |
| Inadequate Planning Discipline | 10. Integrated Management System<br>11. Management Information System<br>12. Cost Accounting Standards |
| | **b. Program Initiation** |
| Faulty Requirements Generation | 13. Program Initiation Event<br>14. Requirements Generation Personnel<br>15. Requirements Planning Resources<br>16. Acquisition Planning Resources<br>17. Requirements-Acquisition Interface |
| Premature Technology Transition | 18. Technology Exploitation Approach<br>19. DoD S&T Strategy Revision<br>20. Technology-Acquisition Relationship<br>21. Technology-User Relationship<br>22. Industry-Led Technology Development |
| | **c. Defense Industrial Base** |
| Excess Capacity | 23. Business-Led Restructure<br>24. Effective Competition Statute<br>25. Sole Source Cost Control<br>26. Commercial-Military Integration<br>27. Public Infrastructure Reduction<br>28. Modified Arsenal System<br>29. Supplier Base Stabilization |
| Low Productivity Growth | 30. Financial Risk Allocation<br>31. Private Investment Incentives<br>32. Public Capital Investment |

leadership, it is more important to examine how good program leadership dramatically impacts the acquisition of affordable weapon systems. This section will identify three top leadership challenges--common to every defense acquisition program--that must be addressed by the government program director and the contractor's program manager.

## Teamwork

The first leadership challenge is the need to create a high performance team. Good teams surface the right issues and implement the correct alternative. Several authors[17,18] have described the necessary conditions for teamwork--from within and between organizations. The most important condition for teamwork in the acquisition setting is trust.[19] Trust flourishes when there are open and effective communications. It also exists when individuals are encouraged to "say what they mean and do what they say."[20]

Many defense acquisition policies tend to promote mistrust and confrontation rather than teamwork. For instance, many DoD acquisition regulations have led to the creation of functional specialties in both the government and contractor acquisition organizations. In turn, these specialties have led to the development of "stovepipe mafias" which tend to take on a life of their own. Over time, these groups replace overall program goals with the sub-optimal goals of the functional organization.[21,22] Open communications are further impaired by physical isolation and matrixing of the functional specialists. Lack of a strong team identity and the "purist" functional perspective inhibit effective decisionmaking. Program risks are not bounded. Decision gridlock occurs. And ultimately, opportunities to reduce cost are lost.

As the defense industrial base and the DoD acquisition work force shrink, the relationship between the government and the contractor must change from confrontation to teamwork. In many cases, a sole source relationship will exist with a supplier of

recognized capability. The government's role must shift from a manpower intensive confrontation--where the government provides "how to" direction and a product control focus--to a more lean role. This new role requires a shift to direction of "what is needed" and to assurance that contractor's business processes are in control.

## Organizational Excellence

The second leadership challenge is the need to establish organizational excellence. Unity of effort and organizational cohesion are critically important in a dynamic and destabilizing acquisition environment. More often than not, the recommendation is made to "somehow" reduce the amount of instability in the acquisition environment. This is the wrong approach. Some sources of instability--Congressional budget cuts--will always be with us. Instead of attempting to control instabilities, program directors should strive to build high performance organizations that can better deal with inevitable program perturbations. They should create organizations that are "instability resistant."

Why do unity of effort and organizational cohesion appear to be major problems in the defense acquisition environment? I believe that the answer can be found in any one of three prominent causes. First, there are no pre-ordained structures or traditions. The first time acquisition of an unseen system--at the cutting edge of technology--means that a new organization must be formed and new business practices established. Second, there is always a need to train some supervisors in place. The sheer size and uniqueness of each major acquisition program guarantees that there will be some first time learners throughout the organization. Third, an acquisition program is always a moving target--the structure must be constantly updated. Unlike most organizations with a relatively static mission (e.g. a tactical fighter squadron, an airbase group, etc.), acquisition organizations are created; evolve and change with each program phase; and then, disappear within a 20-year time period.

How does one build a high performance organization in this kind of dynamic environment? A common structure or framework is necessary for aligning near term activities and guiding long term plans. Program directors should insure that each work group within the organization has a clearly defined "business plan" and a "strategic plan."[23,24,25] Figures 1 and 2 present hierarchical framework for formulating effective business and strategic plans respectively. The business plan describes "how we accomplish the mission today" and documents the structure for conducting daily tasks. The strategic plan describes "how we will accomplish the mission tomorrow." Clearly, the development of a solid business plan is a prerequisite to the formulation of an effective strategic plan. Many well intentioned efforts to implement Total Quality Management (TQM) fail because this fact is not fully appreciated.

In practice, each work group's business and strategic plans should be influenced by--and be visible to--the supervisory, subordinate and lateral levels throughout the government and contractor organizations. Once implemented, these plans provide the structural basis[26] for a strongly cohesive organization. This creates the unity of effort needed to adapt to a changing environment and to accommodate external program instabilities.

## Open Communications

Creation of open communications is the third important leadership challenge. To a great extent, communications will improve with increasing levels of trust, teamwork and organizational cohesion. However, this is not enough. The contractor and the government need an effective management information system, an improved level of office automation and better video-telecommunication capabilities. Electronic media transfer should replace paper reports. The goal should be to internet the entire program and provide timely access to all relevant information by any decision maker--in the government program office, at the prime contractor or at each major subcontractor.

FIGURE 1
BUSINESS PLAN

"The Base"
(How We Accomplish The Mission Today)

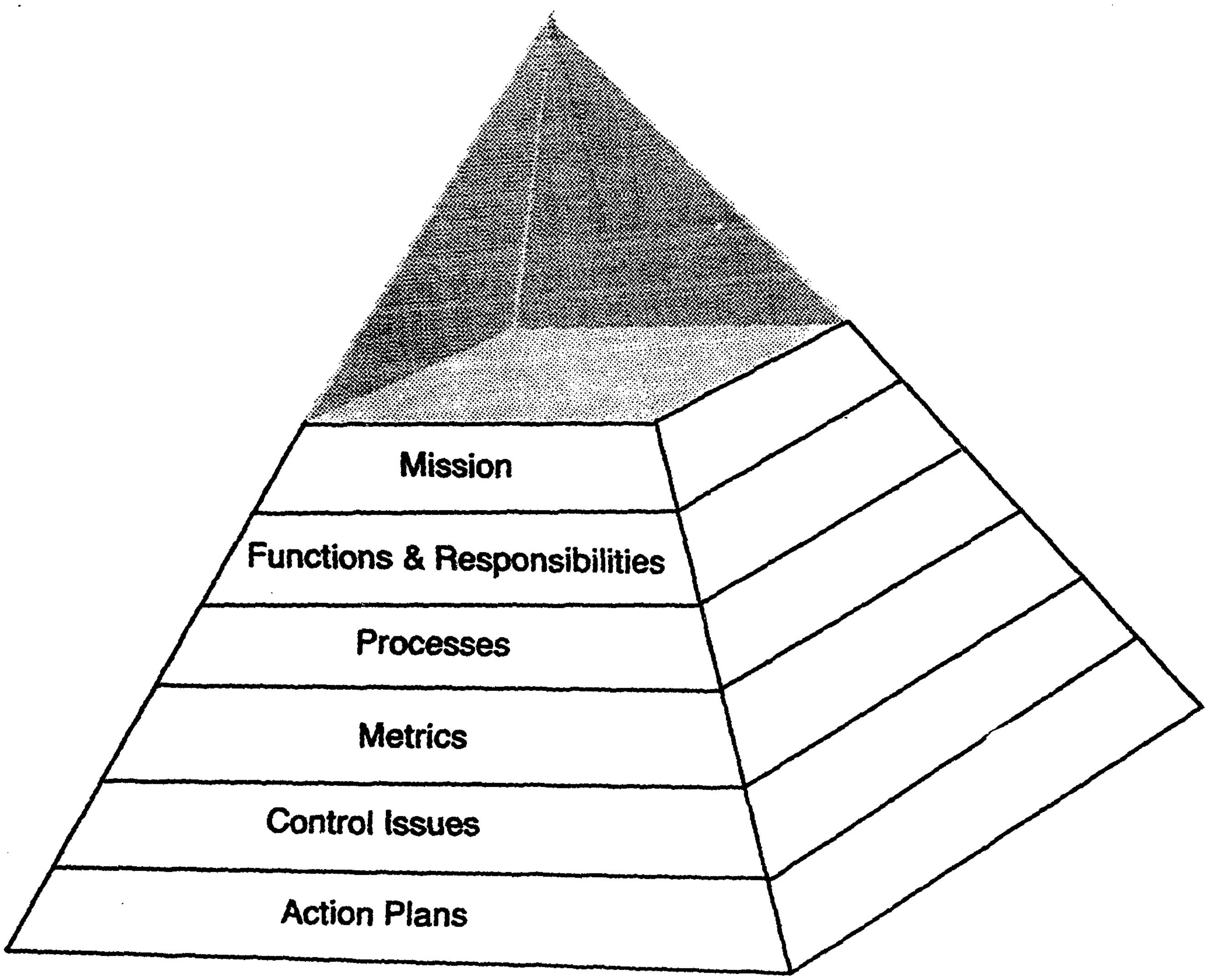
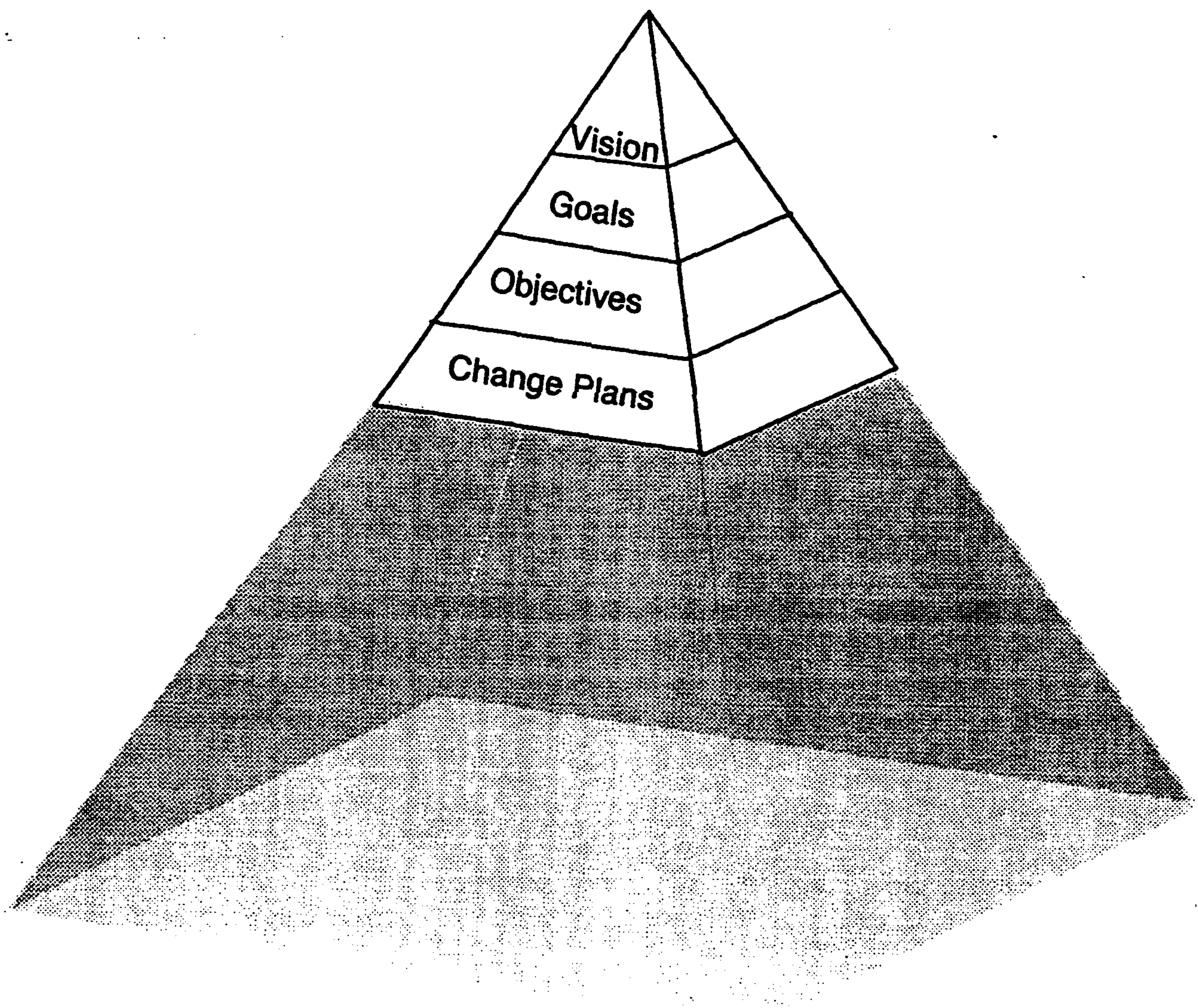


FIGURE 2
STRATEGIC PLAN

"The Cap"
(How We Will Accomplish The Mission Tomorrow)



Several obstacles must be overcome to implement this overall vision. The DoD communications-computer systems community should focus upon development of open standards. Consolidated group purchases of office computer equipment should be discontinued. This practice invariably leads to long delays and delivery of obsolete systems. Interoperability, rather than standardization, should be stressed for office systems. And finally, program directors must take the necessary steps (contract provisions, program budget, etc.) to set aside the necessary resources to implement and then upgrade an integrated management information system.

## Policy Recommendations

Although the program director is responsible for providing effective leadership, senior acquisition officials should consider the following policy recommendations:

1. Program Director's Authority: The government program director must have authority commensurate with responsibility. This includes direct control over the manpower and budget for all program activities. The workload (and commensurate instability) associated with headquarters' taskings and "what if drills" should be reduced through sharp cuts in the OSD and service secretariat staffs. The influence of functional specialties within each services' material commands should be limited to process oversight.

2. Life Cycle Weapon System Management: Program directors should have clear responsibility for life cycle management of a weapon system program--development, production, logistics support and retirement. The acquisition and logistics functions should be combined at the service staff level to facilitate unity of effort.

3. Communications-Computer Systems: Program directors should have maximum freedom of action to quickly respond to office automation needs. Local purchases of program office equipment and computer systems should not require approval from higher headquarters. The communications-computer systems functional staffs should concentrate on development of a DoD-wide architecture and open standards for interoperable data transfer.

## COMPARTMENTED PRODUCT DEVELOPMENT

An effective product development process is probably the second most important determinant of weapon system affordability (see Table I). A concurrent approach, sometimes called systems engineering, concurrent engineering[27,28] or integrated product development (IPD),[29] is a product design and development method which stresses early incorporation of all relevant requirements and integration of all functional disciplines. This process allows downstream testability, producibility and supportability considerations to be addressed during the product design phase along with performance and packaging requirements. This is important because nearly 70% of weapon system life cycle costs are fixed during the design stage of program execution.[30,31,32] Life cycle costs are reduced by correcting deficiencies during the paper stage--rather than making expensive modifications to the system later in the development cycle or living with a costly operational deficiency. Less redesign and rework cycles equate to shorter weapon system development times as well.

American industry is beginning to understand and embrace the integrated product development concept. As a result, many manufacturers have already discarded their traditional serial design practices. The Chrysler Viper Project--a next generation sports car--employed integrated product development methods to meet all performance goals while keeping costs under $100 million (about five percent of the typical cost for a new car design) and getting to the market within three years.[33] A Digital Equipment Corporation product development team redesigned the company's computer mouse and completed the project in 18 weeks--about the amount of time it usually takes "to do hard tooling alone."[34] At Cincinnati Milicron, one of America's most prominent machine tool builders, a "Wolfpack" integrated development team produced a new series of computer numerically controlled machining and turning centers to successfully challenge the foreign competition.[35]

Although concurrent engineering has gained broad acceptance within the Department of Defense, the Department has helped

create a serialized, performance-oriented design culture over the past 40 years. This inertia will not be overcome easily. For instance, source selection criteria still tend to emphasize the technical-schedule factors rather than the management-cost aspects of a proposal. Military users tend to improve system performance through a continuous process of "requirements creep." And finally, the Department is typically not willing to tradeoff performance requirements for a low cost design or a more stable production process.

As an alternative, the Department must establish a rational process for translating the military operator's requirements and concept of quality into a producible and supportable design. This includes working with defense contractors to implement the "house of quality" and quality function deployment (QFD) design techniques gaining increasing acceptance across American industry.[36] It also means "marrying" the design to a low cost "lean production" process.[37] Several concurrent engineering workshops have been held at the Defense Systems Management College to identify barriers to effective implementation of the integrated product development approach.[38]

A new standard, MIL-STD-499B, has been released which provides guidance on implementing a disciplined systems engineering process for weapon system acquisition programs. The Air Force Material Command is implementing integrated product development on the F-22 Advanced Tactical Fighter Program and on several new program starts.[39] Successful implementation of this approach could ease the transition from design to production on major weapon system programs. However, the Department must still come to grips with several key issues.

## Multidisciplinary Teams

The success or failure of efforts to implement the integrated product development concept primarily depends upon the contractor's ability to form effective multidisciplinary teams. In many cases, both the defense contractor and the government

system program office are organized along functional lines--with separate offices for contracting, program control, manufacturing, test and evaluation, and reliability. This problem is compounded by the physical isolation and even geographic dispersion of many of these groups. Although there are no inherent impediments which prevent defense contractors from independently forming a co-located multidisciplinary design or development team, the organization of the government program office tends to influence the contractor's corresponding choice of organization. This means that the government program office should be organized along multidisciplinary lines as well. Once these teams are formed, a strong systems engineering function should be maintained to keep the product teams effectively integrated.

## Paperless Environment

The use of computer-aided design, manufacturing and engineering (CAD/CAM/CAE) tools boost the productivity of an integrated product team.[40,41,42] The goal should be to eliminate paper in the factory and from the acquisition process. The Department of Defense's Computer-aided Acquisition and Logistics Support (CALS) program is an initiative which could accomplish this objective.[43,44] In addition, the use of a digital medium to document the product and tooling designs, the manufacturing process and the support concept will greatly facilitate reconstitution of a cold production line.

The next step is to create "virtual factories" in a synthetic environment--interneted computer simulations of the manufacturing process. This task is included as a major technology thrust area in the new DoD S&T strategy. The Advanced Research Projects Agency (ARPA) is the lead organization for this task.[45] If successful, this capability would allow production processes to be refined--prior to building an entire production line. Under these conditions, learning curves and "learn-as-you-go producibility" would cease to exist.

## Production-Oriented Design Practices

Integrated product development teams will need to place emphasis on product designs that are well within the limits of the selected manufacturing technology. This would allow low cost manufacturing process control techniques[46] to be substituted for a costly inspection, scrap and rework cycle. However, due to limited production runs, DoD design teams must also work hard to make the cost of producing the first article as low as possible. This means a design that requires little direct labor and low investment in program-unique capital equipment.

Two complementary approaches seem possible. Component designs and intermediate assemblies can be made to be self-supporting. Hence, these designs would require little or no specialized hard tooling jigs during the manufacturing process.[47] The second approach requires greater integration of the commercial-military industrial base (to be discussed later). In this case, the team can tailor the design for a dual-use manufacturing operation or a flexible manufacturing environment.

A stable production process must be developed without first building the production line. In order to do this, manufacturing technologies must be developed and <u>deployed</u> with the design of the weapon system. The B-2 bomber program successfully implemented this approach through two Department of Defense programs--the Industrial Modernization Incentives Program (IMIP)[48] and the Manufacturing Technology (MANTECH) Program.[49]

Although the B-2 case was successful, there have been many failures associated with IMIP and MANTECH as well. In these less successful cases, the problems could be traced to either a lack of sufficient funding,[50] a lack of coherent strategic focus by the Defense Department or Congressional "earmarking" of up to 75 percent of the available funds.[51]

In order for specific manufacturing technology investments to be effective, the strategy must be "to attack production costs as a total system."[52] All three elements of a production enterprise--advanced manufacturing technology, the product

development process and the production organization--must be addressed simultaneously to build affordable weapon systems. For example, there is good empirical evidence[53] that the full benefits of automation can not be realized until a lean production organization is established first. If advanced manufacturing technologies are not properly integrated with the people and organization, the need for more indirect service workers offsets the expected efficiency increases associated with a particular technology.

## Policy Recommendations

Defense contractors have the primary responsibility for implementing a concurrent engineering or an integrated product development culture within their organizations. However, the government has a role to play as well. The following policy recommendations are offered:

4. Contracting Practices[54]: Update the government's procurement regulations to support implementation of integrated product development--especially those regulations which dictate incompatible design and business practices.

5. Performance-Cost Trade Flexibility: The military services (and the JROC for ACAT ID programs) should provide more freedom of action for developers to tradeoff system performance for a low-cost production approach. Control user-generated "requirements creep." Adopt delivery profiles based upon minimum economical rates of production. Avoid production stretch-outs and over facilitization.

6. Low Cost Design Practices: DoD should encourage low cost design practices. Weight source selection criteria towards the management and cost factors. Encourage design engineers to increase modularity, reduce the need for custom components and increase parts standardization. Emphasize the use of self-supporting assemblies to reduce the need for hard tooling.

7. Computer-aided Acquisition: CALS is an existing DOD initiative that is directed at establishing open standards for interoperable transfer of weapon system documentation and data. It should be broadened to develop the open systems standards needed to easily integrate CAD/CAE/CAM equipment and software. The goal should be to create a

seamless design, engineering and manufacturing environment. This initiative should receive appropriate emphasis to produce tangible results sooner.

8. Manufacturing Technology Deployment: Emphasize manufacturing technology deployment--not just development. The DoD should purchase large numbers of standardized machine tools and robotic equipment to create a stable market for domestic equipment producers. These items should be provided to qualified third and fourth tier defense suppliers to encourage broad technology deployment. Investments in specialized manufacturing technology (IMIP and MANTECH) should be directed towards specific weapon system programs with defined production applications. The new DoD S&T strategy for the affordability thrust area should contain roadmaps for deployment of technology investments.

9. Design Culture Harmonization: Eliminate the separate functional disciplines for development engineering, manufacturing and logistics. In the past, these separate "stovepipes" have led to compartmented and serialized design practices--within the government and in the defense industry. Instead, combine these disciplines to create an integrated culture--acquisition and logistics engineering.

## INADEQUATE PLANNING DISCIPLINE

Good planning discipline is an effective hedge against the effects of external program instabilities. This is the third most important determinant of weapon system cost (see Table I). The key features of a good planning system are: a deep planning horizon, linkage of the program's cost-schedule-performance elements, and a capacity for frequent program replanning.

### Deep Planning Horizon

A deep planning horizon provides a depth of understanding about the work to be accomplished and program risk impacts. It means having executable plans--down to individual cost account work packages--through the end of the contracted effort. Many defense acquisition programs suffer from the "6-month rolling wave" syndrome--executable program plans are not established until six months before the activity is programmed to occur. The most common reason given in defense of this practice is that the

plans will have to change during this time interval. Although true, the visibility gained through long-term planning should not be sacrificed.

## Linkage of Cost-Schedule-Performance

The essence of program planning balance is the linkage of the program's cost, schedule and performance elements. It means having a unified system for relating the statement-of-work and award fee plan (if applicable) with the work breakdown structure, task exit or completion criteria, cost performance reporting, and program schedules. Although many defense acquisition programs start with and maintain at least a formal skeleton of linkage between these planning elements, the day-to-day management of the program becomes dependent upon the uncoupled output of many informal planning systems.

## Planning Flexibility

The key to disciplined planning is flexibility--the ability to easily incorporate work-arounds or turnaround a comprehensive replan of the entire program. The capacity to rapidly explore alternate planning options provides the breadth of program visibility needed to deal effectively with program instability. Without this capability, planning horizons shrink and program balance is lost. Under these conditions, less attention is devoted to long-term program impacts, risk management strategies, and opportunities to improve system affordability. Due to the size and complexity of defense acquisition programs, planning flexibility requires a substantial investment in the program control infrastructure--people, processes and a computer based management information system.

## Policy Recommendations

Although the government program office and the defense contractor have the lead for instilling planning discipline,

senior DoD acquisition officials should consider the following policy recommendations:

10. Integrated Management System (IMS): A new contractual approach is needed to provide a framework for agreement on the program's cost-schedule-performance baseline. Serious consideration should be given to DoD-wide implementation of the F-22 program's contract provisions for an IMS.

11. Management Information System: Encourage the use of a common, computer based management information system by the government-contractor team. Waive some DoD requirements for contractor reports in lieu of government program office access to real-time program status.

12. Cost Accounting Standards: The Cost Accounting Standards (CAS) must be updated to improve cost visibility and capture current business practices.

## PROGRAM INITIATION

There appears to be a problem with the way we start defense acquisition programs. One question immediately comes to mind. Do we adequately identify program risks? More often than not, the answer is not encouraging--we fail to identify the "true" mission requirements, to bound the program costs or to develop a realistic acquisition strategy. As a consequence, most programs are poorly postured from the outset to meet performance goals on time and within budget.

How can we do a better job of getting programs off on the right track? As shown in Table I, we must repair two broken processes. The first order of business is to gain control over the requirements generation process. The second challenge is to implement a workable technology transition process--one that transitions mature technologies at the proper time.

### FAULTY REQUIREMENTS GENERATION

The breakdown in the requirements process is clearly evident to defense contractors. Many defense industry executives have expressed concern over the ability of the government to define reasonable and stable weapon system requirements.[55] This problem

is most acute at program initiation and continues throughout the development stages of a program. In some cases, contractors are frustrated with having to act through a program office rather than to deal directly with the end user.[56]

In theory, DoD Directive 5000.1[57] and DoD Instruction 5000.2[58] define an integrated management framework for maintaining effective interfaces among three DoD decision making systems--the Requirements Generation System, the Acquisition Management System and the Planning, Programming, and Budgeting System (PPBS). These guidance documents also specify an event driven acquisition process in which mission needs, alternative concepts and affordability goals are evolved into system specific requirements, a stable design and unit costs.

The first milestone--Milestone 0--is the initial interface between the requirements generation and acquisition management systems. Prior to this milestone, the requirements generation community--primarily military operators and users--have identified, validated and prioritized a projected mission capability deficiency and material need. Milestone 0 approval allows the acquisition community--a small cadre of career acquisition professionals--to conduct concept exploration and definition studies and provides authority to budget for a new major program. During this phase, the user helps evaluate the potential material alternatives and establishes minimum acceptable requirements for key system parameters.[59] The second milestone--Milestone 1--grants approval to demonstrate and validate competing design approaches for the selected concept.

Although this process appears sound on the surface, a recent RAND report[60] cites the lack of adequate acquisition planning information at Milestone 0. It also cites the need for a logical program initiation event at Milestone 1. Two more authors, Ferguson[61] and Sullivan,[62] each identify a similar need for more adequate planning resources prior to Milestone 0--in both funding and qualified personnel. Without adequate resources, mission area needs analyses are limited and generate few viable alternatives. After Milestone 0, the planning resource shortage

creates a serious mismatch between the output of the requirements process and the needs of the budget process--"budget supportable" programmatic information does not exist. This causes immature program cost and schedule information to flow into the PPBS. It "locks" the program into a premature single solution.[63] This problem is compounded further when personnel without "hands-on development experience" specify detailed system performance requirements[64] in an Operational Requirements Document.

The ability to evolve requirements, bound program risks and define an executable program is a direct function of manpower and funding resources. If a process is not in place to bring on the right numbers and types of personnel, the initial direction of the program will be determined by an inadequate program office cadre and an unqualified service headquarters staff. Experienced military officers--users with an operations research background and acquisition professionals with development expertise--are the critical manpower resources that must be made available at program initiation.

Weapon system acquisition risk can be greatly reduced by exercising better control over the interface between the requirements generation and acquisition management systems. I recommend the following corrective actions:

13. <u>Program Initiation Event</u>: Amend DODD 5000.1 and DODI 5000.2 to identify Milestone 0 as approval to develop a proposal to initiate a program. Initiate acquisition management planning (form SPO cadre) prior to Milestone 0. Milestone 1 is the program initiation decision. Harmonize PPBS expectations for detailed programmatic information with output of concept exploration activities.

14. <u>Requirements Generation Personnel</u>: Improve expertise of service, CINC and JCS personnel to perform mission area needs analyses by requiring formal operations research education.

15. <u>Requirements Planning Resources</u>: Strengthen the requirements capability of the operational commands and the CINCs. Allocate sufficient manpower and funding for this function--especially during the pre-Milestone 0/1 requirements definition phase. Provide resources to keep ORDs current through product development cycle.

16. <u>Acquisition Planning Resources</u>: Strengthen the early

acquisition planning capability of the material and systems commands by allocating sufficient manpower and funds to form a new program cadre prior to Milestone 0 and a full-strength program office at Milestone 0 approval.

17. Requirements-Acquisition Interface: USD[A] should serve as vice-chairman of the JROC. The DoD acquisition community must have authority to challenge and accept (or reject) MNS and ORD requirements. Formalize a service [and joint] procedure for a program-specific exchange of planners between the operational and material commands on a temporary duty basis (3 month tours).

**PREMATURE TECHNOLOGY TRANSITION**

The fifth major source of program cost growth is early transition of an immature technology (see Table I). The results are entirely predictable when technologies with high development risk are adopted as the program baseline--an expensive technology development effort must be undertaken. In turn, this effort holds the rest of the program "hostage" until a technical solution is found. The root cause for premature technology transition can be traced to the role of technologists, users and developers during program initiation.

The requirements generation process directed by DODD 5000.1 and DODI 5000.2 is a problem-oriented approach--an operational need is evolved into system requirements. However, a solution-oriented approach is also possible--a new technology can be exploited to yield a superior weapon system. The former approach is known as "requirements pull" while the latter is commonly described as "technology push."[65] The advocates for "technology push" solutions--either from government or industry--tend to be the applied researchers, scientists or technologists associated with the breakthrough technology. They proceed with an advanced technology demonstration effort to show that a technology is ready for a weapon system acquisition program. In order to implement a "technology push" solution, the technologists "lobby" users to frame a concept specific "operational need" and assign a high priority on an integrated priorities list (IPL). This course of action essentially circumvents the Milestone 0 event.

Program initiation occurs at either Milestone 1 or 2 without the benefit of early involvement by "hands-on" developers.

The new DoD Science and Technology (S&T) Strategy[66,67,68] attempts to reduce the possibility of premature technology transition through more rigorous development and demonstration of advanced technologies. The strategy centralizes control of the defense technology program under the Director, Defense Research and Engineering. In turn, seven major thrusts were established to provide technology "push" roadmaps for the applied R&D efforts of the department. The strategy stresses the use of prototypes and Advanced Technology Demonstrators (ATDs) to demonstrate risk reduction at the system, a subsystem or a component level of technology integration.

Although the goal of reducing technical risk through a rapid prototyping approach is laudable, the new strategy does not bridge the gap between the S&T community and the developers. In order to adequately bound program execution risk, the developers or acquisition community must help guide the formulation and conduct of the technology risk reduction efforts. These demonstrations should occur as a parallel effort in conjunction with Phase 0 Concept Exploration activities aimed at developing the program initiation proposal. A more direct, decentralized linkage between the laboratories and acquisition product divisions would greatly facilitate this interchange.

The risk of starting a development program with immature technology can be greatly reduced by implementing a disciplined technology transition process. I recommend the following policy changes:

18. Technology Exploitation Approach: Amend DODD 5000.1 and DODI 5000.2 to provide a structured program initiation approach for exploiting "technology push" solutions. Use acquisition personnel with hands-on development expertise to evaluate technical risk and alternative concepts. Military utility should be assessed by users with a formal education or training in operations research. Evaluate concepts with the aid of advanced models and simulations.

19. DOD S&T Strategy Revision: Limit centralized direction

of defense technology program by the OSD staff to multi-service applications and interdisciplinary technologies. ARPA continues to serve as the principal executing agent.

20. Technology-Acquisition Relationship: Direction of service-specific technology thrusts, transition roadmaps and programs should be further decentralized to the research and engineering centers within each service's material and systems commands. Technology program execution should still be conducted by the laboratories assigned to parent product divisions.

21. Technology-User Relationship: Service and joint operational commands should conduct annual reviews to assess the potential military utility of technology thrusts, transition roadmaps, and programs.

22. Industry-Led Technology Investment: Place greater emphasis upon industry-led technology efforts with government participation and funding share no greater than 30 percent of the total effort.

## DEFENSE INDUSTRIAL BASE

Weapon system cost growth is driven, in part, by an increasingly inefficient defense industrial base. As shown in Table I, two major cost drivers must be dealt with to make weapon system production more affordable--excess productive capacity and low productivity growth. In most instances, these two forces appear to be beyond the control of those responsible for execution of individual weapon system acquisition programs. From this perspective, the "deck" appears "stacked" against a low-cost outcome--before the first program dollar is spent.

## EXCESS CAPACITY

Over the last 50 years, the Defense Department has created a built-in bias for expansion of the industrial base. This trend was set in motion with legislation like the 1940 statute (P.L. 76-426) which encouraged "the award of contracts to not only the lowest bidder but also to the three lowest bidders" in order to create competition and expand the industrial base for World War II.[69] The bias towards expansion gained more momentum during the Korean War era with passage of more sweeping mobilization

statutes and policies, including the Defense Production Act of 1950, which preserved excess defense industrial capacity.[70] Although there have been some sharp cyclical swings in defense procurement budgets, a 0.3 percent real expansion in defense procurement spending has been sustained since the Korean War.[71]

By 1980, this spending pattern created an unbalanced capacity between the prime and supplier tiers of the defense industrial base.[72] The bias towards expansion led to excess capacity at the prime contractor level while cyclical instability tended to force many second- and third-tier subcontractors out of the defense business. During the 1980's, the procurement reform initiatives aimed at increasing accountability and competitive prototyping further exacerbated this capacity imbalance problem within the defense industry. The drive for more accountability led to more restrictive contracting procedures--added rules and costs which caused many subcontractors to "opt-out" of the defense market.[73] At the prime contractor level, "fly-before-you-buy" policies were adopted to limit the government's cost exposure until a working prototype could be evaluated. This caused prime contractors to incur up-front R&D costs and become increasingly debt leveraged. To recover these costs, the prime contractors retained their excess capacity--facilities and design teams--in anticipation of a split production contract or the next big development program.

Statutes aimed at increasing competition tended to generate excess capacity as well. Many professionals believe that the Competitiveness in Contracting Act (CICA) was passed without thoroughly examining the impacts of "false competition" upon the productive capacity and cost structure of the defense industry.[74] The natural outcome of "false competition" is too much capacity chasing too little work. Eventually, this led to a large increase in the overhead costs for contracts awarded. Hence, the imperative to maintain "false competition" drove the government to accept high overhead costs as allowable costs. As a result, defense management emphasis shifted to cost estimation--rather than cost control.[75]

Defense contractors must take the lead in solving the excess capacity problem. There are indications that this business-led shake-out was already underway in 1992 with Lockheed's purchase of General Dynamics' aircraft division and Martin Marietta's acquisition of General Electric's aerospace division. This process will continue over the next several years. If a corporation does not command a number one or two competitive dominance in the field, a shut down or sell off will occur. In turn, the acquiring corporations must strip off excess capacity and consolidate the business and contract base. Eventually, one or two prime contractors will survive the restructures and consolidations in each major defense sector.

The Department of Defense, for the most part, has pursued a laissez-faire approach towards management of the industrial base. This policy must change. The goal should be to create stable, long-term relationships with the most qualified contractors in each major defense sector. This goal can not be reached unless the Department actively rationalizes the production base. At the prime contractor level, the government must be ready to control costs and incentivize private capital investments in a sole-source or a diminished competitive environment. At lower levels within the supplier base, the Department should encourage a greater amount of dual-use commercial-military integration--in technology, products and operations.

The Department should not attempt to continue high cost policies designed to preserve "false competition." In most cases, the government owned-government operated (GOGO) portions of the defense industrial base[76] should be privatized. For example, aircraft engine depot facilities and overhaul functions could be sold to the two major engine manufacturers--Pratt & Whitney Aircraft and General Electric--to increase each firm's business base and economies of scale. In the turbine engine sector, adequate price competition insures that cost savings will be passed along to the government. Other opportunities for privatization--like space launch services--may exist and should be explored.

Excess defense industrial capacity is judged to be the sixth leading cause of excessive weapon system cost. The Congress and the Department of Defense should consider the following policy recommendations as a basis for rationalizing the capacity of the defense industrial base:

23. Business-Led Restructure: Abandon laissez-faire economic policies. Active management of the industrial base sectors should be delegated to a cognizant DoD research & engineering center. Encourage a business-led consolidation of excess capacity (design teams and facilities). Pick "winners and losers" only as a last resort. Approve mergers which strengthen the efficiency of the defense industrial base. Set stringent limits for allowable overhead costs. Establish stable production runs for rationalized product lines.

24. Effective Competition Statute[77]: Replace the requirement for "full and open competition" with a statute for "effective competition." Allow acquisition strategies which establish effective competition without maintaining a second source capability throughout all program phases.

25. Sole Source Cost Control: Develop and implement improved program management and contracting policies for cost control in a sole source environment. Increase the use of award fees. Improve real-time cost visibility. Create team-oriented government-contractor relationships.

26. Commercial-Military Integration: A new CSIS report[78] gives an excellent action plan for removing the following four barriers to greater integration of the defense and commercial sectors: 1) unique accounting requirements and audits; 2) obsolete military specifications and standards; 3) unlimited technical data rights; and 4) unique contract requirements. Challenge the need for defense unique procurement practices--especially for piece-parts and subassemblies. Make greater use of "dual-use" commercial technologies and processes (products where appropriate).

27. Public Infrastructure Reduction: Close most of the DoD logistics centers. Maintain minimum amount of government-owned facilities and functions deemed essential to support wartime readiness needs. Retain minimum essential amount of GOGO production facilities. Eliminate all non-unique government laboratory facilities.

28. Modified Arsenal System:[79] In sectors where the market mechanism has failed (unique defense requirements, a sole source supplier and declining productivity), return to a modified arsenal system--on a government owned-contractor operated (GOCO) basis. Avoid inefficiencies traditionally associated with arsenals through a capital goods and work force investment program managed by the contractor.

29. Supplier Base Stabilization: Introduce more stability into the second- and third-tier supplier base. Promote long-term, cooperative supplier relationships and continuous improvement culture. Thoroughly evaluate prime contractor "make or buy" decisions from the perspective of supplier base stability.

**LOW PRODUCTIVITY GROWTH**

As shown in Table I, low productivity growth in the defense sector is the number seven major source of cost growth. Two trends are adversely affecting productivity growth within the defense portion of the industrial base--more isolation and less investment. Let us look at the influence of defense sector isolation first.

The demand for highly unique and specialized military equipment has caused the defense sector to become more isolated from the civilian economy.[80] In turn, this has impeded the two-way transfer of technology between both sectors. In spite of calls for more reliance on "marrying defense and commercial technologies,"[81,82] defense "spin-off" and commercial "spin-in" are becoming increasingly rare occurrences--especially at the prime contractor and major subcontractor levels. A small defense procurement base ($60 billion out of a $6 trillion economy) means that the defense sector is more dependent on the commercial sector for the "spin-in" of low cost innovations. This dependence is most evident in the telecommunications and information processing sector--the military depends on innovations in this sector for command, control, communications and computer ($C^4$) equipment. Hence, productivity suffers from the failure to capture the flexibility and innovation associated with a more dynamic commercial sector.[83]

Low productivity growth can be attributed to a lack of capital investment as well. There is substantial evidence that "defense contractors invest in new manufacturing equipment and technologies at only half the rate of comparable commercial firms."[84] Although current procurement policies stress maximum use of private capital in defense programs, there is intense

competition for private investment funds. In some cases, like the McDonnell-Douglas C-17 program, the size of large weapon system acquisitions have challenged the financial capacity of even our largest defense contractors. This kind of financial problem is made worse by the acquisition reform and competition initiatives, discussed earlier, which tend to increase the up-front costs and risks borne by the contractor. As a consequence, many defense contractors are highly debt leveraged with little capital for investments with modest short term returns.[85,86]

In addition to cash flow considerations, there are opportunity cost impediments to the use of private capital on defense programs. Most defense programs can and do provide long-term opportunities for a positive rate of return on capital investments in automation and other specialized manufacturing processes. However, these investments are routinely not made because the defense program can not compete with the corporate "hurdle rate"[87] opportunities available elsewhere. The investment problem is worse for third- and fourth-tier defense suppliers. At these levels, investment decisions are made in an environment where the effects of a shrinking and unstable defense business base are more pronounced.

Clearly, the continued infusion of commercial innovation and the use of private capital in the defense industrial base are under siege. Congress and the Defense Department should consider the following additional policy recommendations as a basis for improving the productivity of the defense industrial base:

30. Financial Risk Allocation: Pursue a more balanced approach towards sharing program financial risk. The government should adopt a "pay-as-you-go" policy with regard to up-front R&D costs. Avoid contract types (fixed price, etc.) that shift a disproportionate share of financial risk onto the contractor.

31. Private Investment Incentives: The Congress should "level the playing field" for defense-related capital investment decisions. Enact a special defense investment tax credit or other similar incentive to increase the rate of return for investments on defense programs. The goal should be to lower opportunity costs and expand the investment time horizon of defense contractors.

32. Public Capital Investment: In sectors where defense purchases are a major fraction of the business base or perhaps the only customer (naval nuclear reactors, etc.), the government should take more responsibility for assuring productivity improvements. Increase investment budgets. Improve management of government assets.

## SUMMARY

"Our long term security requires that we sustain our capability to produce first class weapon systems."

- Donald J. Yockey, USD(A) [88]
June 18, 1991

As former Undersecretary Yockey points out, a "world class" production capability is needed to maintain a qualitative advantage--the winning edge. However, this vital imperative--so crucial to our national security--is jeopardized by the excessive cost growth of new and upgraded weapon systems. Hence, our challenge is to develop and execute a strategy for improving the affordability of weapon systems.

Seven sources of cost growth, judged to be the leading causes, have been examined. From this discussion, a strategy was developed to change the acquisition culture--one that elevates the importance of cost control and puts this imperative on an equal footing with expanding the performance envelope of our weapon systems. Policy recommendations, summarized in Table II, are offered for consideration by senior defense acquisition officials. This is an initial response to the defense acquisition challenge.

The first priority is to shorten the development cycle and limit costs by improving program execution. Leadership--at the program director's level--will make this happen. The key objectives are to implement a superior product development approach and to strengthen planning discipline. Planning depth and a high performance organization provide the "internal" strength necessary to deal with an inherently unstable external program environment.

The next priority is to improve program initiation. This means getting programs started on the right track--with bounded risks and a reasonable acquisition strategy. To do this, we must fix two broken processes--requirements generation and technology transition. In each case, the root cause of the problem is institutional. We must improve the interfaces among the operators, developers and technologists.

And finally, the last step is to improve the efficiency of the defense industrial base. Excess capacity at the prime contractor level must be eliminated through a business-led restructure. More stability must be introduced into the second and third tiers of the defense supplier base. Government incentives are required to attract private capital for long-term productivity growth.

These are the first few tentative steps towards a response to the defense acquisition challenge... the last mile still awaits us.

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"Most important were the facilities constructed with the War Department's own funds. There was some expansion at the arsenals and depots operated by the War Department, but for the most part the new War Department-owned facilities were built by private construction companies under cost-plus-a-fixed-fee contracts, and operated by private contractors for a management fee."

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